

NILGIRI TAHR, ERAVIKULAM NATIONAL PARK AND CONSERVATION

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ABSTRACT

The conservation and management considerations relevant to Nilgiri tahr and other species in Eravikulam National Park and the region are discussed. It is recommended that:

1. Burning of the grassland be continued on a planned basis;
2. Eravikulam National Park be expanded to include all the areas utilized by tahr, and additional forested land important for the preservation of other species;
3. The national park boundary be surveyed and an official map of the park produced;
4. Measures be taken to reduce human disturbances;
5. A conservative attitude towards development and management be maintained as the most appropriate philosophy for Eravikulam National Park;
6. Investigations be carried out on the status and ecology of plant and animal species found within the national park.

In a regional context it is suggested that:

1. Sport hunting of Nilgiri tahr be considered as a possible conservation method;
2. Reintroduction of Nilgiri tahr be attempted if suitable habitat is available and can be protected;
3. A cooperative policy be developed for the conservation of large mammals which range outside the national park.

INTRODUCTION

The Nilgiri tahr, (Hemitragus hylocrius Ogilby, 1838) is restricted in distribution to the hills of South India. It is congeneric with the Himalayan tahr, (Hemitragus jemlahicus), found from Kashmir to Bhutan (Schaller 1973), and the Arabian tahr, (Hemitragus jayakari), which is confined to the mountains in Oman (Munton [1979]). In contrast to the thick long pelage of the Himalayan and Arabian tahrs, the Nilgiri tahr has a short gray-brown or dark brown coat. The facial markings, which are particularly distinct in mature males, consist of a dark brown muzzle separated from a dark cheek by a white stripe running down from the base of the horns. The horns are more circular in cross section than those of Himalayan and Arabian tahr, with a flattened inner margin. The frontal keel projects towards the center, and the horn tips flare much less than do those of the other 2 species of tahr.

Due to its restricted distribution and limited numbers, the Nilgiri tahr is included in the Red Data Book as a vulnerable species (Goodwin and Holloway 1972), and has been barred from sport hunting under Schedule I of the Indian Wildlife Act (1972).

This paper is based on a study conducted at Eravikulam National Park, Kerala. Since this area has the largest population of Nilgiri tahr, and is perhaps ideal habitat for the species, the patterns described here may vary somewhat for other areas, particularly those with smaller, more isolated, and more disturbed populations. Some topics considered here will be given complete coverage in later publications.

The study was conducted from 8 July 1979 to 27 September 1981. The Park, which covers an area of just over 100 sq. km. lies on the boundary between Tamil Nadu and Kerala along the crest of the Western Ghats. Anai Mudi, at 2,697 m, is the highest point south of the Himalayas and falls in the southern portion of the park. Figure 1 shows the approximate boundary of Eravikulam National Park in relation to local landmarks.

The primary study method was by direct observation of animals in the wild, with intensive study of the tahr ranging between Vaguvarrai Estate and the Eravikulam Hut. These animals were habituated to the close presence of an observer, which allowed observations to continue throughout the poor weather of the monsoon which coincides with the rutting season. In addition, about 60 animals, mostly adult females, were marked with color-coded collars to aid in individual identification. For censusing, the park was divided into a number of sections. The boundaries of these sections were along natural divisions of the habitat and the tahr population. All the tahr in each section were then counted on consecutive days. Because of the tahr's tendency to live in open country, it was possible to count and classify virtually all animals within the park with the aid of binoculars and a spotting scope.

Visits were also made to the Grass Hills of the Anamalais adjoining to the north, and to the Mukerti area of the Nilgiri plateau to gather comparative information.

As is recounted by Baig and Henderson (1978), modern settlement of the High Range began with the establishment of the North Travancore Land Planting and Agricultural Society in 1879.

Estates were developed in the ensuing years, which yielded such crops as tea, coffee, and cinchona. Over the years, tea became the predominant crop and commercial control was vested in the Kanan Devan Hills Produce Corporation.

The early plantation managers were from the United Kingdom and they maintained an active interest in outdoor sports including hunting and fishing. Game taken included Nilgiri tahr, sambar, barking deer, gaur, wild boar, leopard, and tiger, while angling focused on the introduced brown and rainbow trout. To improve and regulate these activities, the High Range Wildlife Preservation Association, and the High Range Angling Association were formed in 1928 and 1933, respectively. The high country, including the plateau of what is now Eravikulam National Park were too high and too cold, and had soils unsuitable for plantation crops. Such lands under the Associations' purview were maintained in a wild state for use in outdoor sport. The harvest levels of fish and game, monitored by the Associations, were very low, and the land was kept in its original condition. Mudhuvan tribals were employed as game watchers, and the managers of nearby estates were appointed as wardens for the various areas.

In 1971 the Kanan Devan Hills (Resumption of Lands) Act ruled that all land not actually under cultivation be vested with the government as part of a land reform program. This caused some concern that the unspoiled land of the Eravikulam Plateau would be converted to agricultural uses. However, thanks to the representations on behalf of preserving the area by J.C.

Gouldsbury, then chairman of the High Range Wildlife Preservation Association, and the foresight of the Kerala state government, the area was declared a wildlife sanctuary in 1975, and then, in 1978, upgraded to a national park.

The planting community in the Nilgiri Hills filled a similar role. Formed in 1877, the Nilgiri Wildlife Association gave support and advice on the regulation of sportsmans' activities in the area. However, with the current total ban on sport hunting, its influence has diminished.

Although the Western Ghats span 3 states, similar ecological economic and social conditions are found along their length. For this reason, conservation issues pertinent to one area in the Western Ghats are often relevant to the range as a whole. With increasing human activity and development in the area, there is a need to integrate ecological and conservation concerns into the planning and execution of these activities.

NILGIRI TAHR

Distribution and Population Size

Nilgiri tahr are found only along the Western Ghats in South India, and even within this small area they are confined to the crest of the range, usually at altitudes of over 1200 m. It is thought that tahr once ranged through most of the Western Ghats (Davidar 1978), but current populations are distributed between the Nilgiri Hills in the north, and the Tiruvannamalai Peaks in the south. We owe our knowledge of the distribution of Nilgiri tahr populations to the dedicated survey work of E.R.C. Davidar

and others (see Davidar 1978). The results of these surveys, updated for Eravikulam National Park and the Grass Hills of the Anamalais, are shown in Figure 2. It should be noted that these locations do not necessarily represent distinct population units. For instance, some are distributed over ecologically continuous habitats, such as the Nilgiri Hills and Silent Valley populations, or the Eravikulam National Park and the Grass Hills of the Anamalais populations. On the other hand, some locations represent a number of scattered populations, such as those from the Topslip and Parambikulam area, or the Amaravati slopes. Due to the ruggedness and inaccessibility of the terrain, the shyness of the animals, and constraints of time, not all populations were actually censused. Many of the populations were estimated based upon sign and accounts given by local informants. Probably no populations have been overlooked and therefore, the best estimate of the current wild Nilgiri tahr populations is the resulting total of 2,235.

In addition, there are 4 captive groups of Nilgiri tahr. Of these, 1 is located in India at the Trivandrum Zoo, Kerala. The other 3 groups are in the United States, at the Memphis Zoo and Aquarium in Tennessee, the Minnesota Zoological Garden (near Minneapolis), and the San Diego Zoo in California. The group at the Trivandrum Zoo consisted in 1981 of 1 adult male, 2 adult females, and 2 offspring born that year. In 1983 the Memphis Zoo group was of 10 adult males, 13 adult females, and 1 young born that year; the Minnesota group was of 6 adult males, 5 adult females, and 4 young; and the San Diego Zoo group was of 2 adult males and 2 adult females. All of the animals in captive groups

were originally from what is now Eravikulam National Park, and all of those in the United States are descendants from an original group of 1 male and 2 females.

Habitat

Tahr typically inhabit the fringes of the rolling grassy plateaus of the Western Ghats and the adjacent cliffs and steep rock slabs (Figure 3). This grassland is composed of perennial grasses, and at Eravikulam National Park, cover values usually exceeded 90%. The common grasses, Eulalia phaeothrix, Ischaemum indicum, Arundinella fuscata, Tripogon bromoides, Tripogon ananthaswamianus (a species discovered during the study), Andropogon lividis, and Sehima nervosum accounted for most of the cover. In the upland grassland, sedges were about 1% of the cover, with forbs between 1% and 3%. Some areas were thickly covered with the shrub Strobilanthes kunthianus. Valleys and hollows contained patches of evergreen forest known as sholas, which varied in breadth from a few meters along streams to extensive forests in the lower valleys. Steep gneiss outcroppings and cliffs often form the edge of the plateau, and while rarely vertical, these areas serve as excellent cover for escape and parturition. Often slopes along the base of the cliffs are covered with taller shrubs and grasses, including Chrysopogon zelanica, Strobilanthes kunthianus, and Eupatorium glandulosum.

Group Size and Composition

In social grouping, Nilgiri tahr show a pattern similar to that of most other Caprini (Schaller 1978, Geist 1971, and

Nievergelt 1974). The basic units of the mixed groups were associations of adult females and their subadult offspring. Adult males joined these groups during the rut and departed during the rest of the year. The proportion of time spent away from the mixed groups was positively correlated with the age or maturity of the males. Females and subadults occurred in groups of all sizes ranging from 2 to a maximum observed of 150 (that included a dozen adult males). These groups were open, and the animals forming them split and reunited often. Females were rarely seen alone, and such sightings were usually in the context of isolation associated with parturition. By contrast, male groups reached a maximum size of 21, and single males were common. Like the mixed groups, male groups split and reformed freely.

Movements

Nilgiri tahr did not distribute themselves evenly throughout their range. Rather, they frequented the plateau areas adjacent to the steep cliffs and slabs. The grassland of the plateau offered the best grazing, but only those areas near cliffs were visited. Figure 4 shows the area of Eravikulam National Park and environs used by Nilgiri tahr. This area used by tahr was further subdivided into about 7 areas termed common home ranges. These common home ranges were home ranges shared by a subpopulation of females and subadults. They were discrete and usually did not border on one another. The females and subadults, whether they were in one large group or several smaller ones, remained within each area, and generally had no

contact with animals from adjacent ranges. Adult males, on the other hand, moved frequently between adjacent ranges, and also spent large portions of their time in areas outside the mixed group common home range. Such wanderings took them toward the center of the plateau, onto areas of the plateau margin extending past the usual movements of the mixed groups, and onto the slopes below the steep cliffs and slabs. Mixed groups did not venture as far onto the plateau and they did not use the slopes below the cliffs and slabs as much as the adult males. This pattern of movement contrasts markedly with that shown by Himalayan tahr in Langtang National Park, Nepal, where the males separate from the mixed groups and move to higher elevations (Green 1978). This is impossible for Nilgiri tahr males, since the mixed group common home range areas include the tops of the highest peaks.

The Annual Reproductive Cycle

Nilgiri tahr gave birth to single young, most of them between about 10 January and 15 February (in 1981). During this time of year, the nights were clear and cold, and the days clear and sunny. Since the best grazing occurs with the fresh regrowth after the grassland fires in February and March, this would seem to indicate that weather conditions, rather than forage production, are the major determinant of the birth season. In addition, the few females which lost their young soon after birth conceived again almost immediately, and gave birth again in the middle of the monsoon.

With a gestation period of about six months (Caughley 1971), a rut in mid summer corresponds to the mid winter birth season.

This places the rut in the middle of the monsoon. Weather during the rut also played an important role in determining the timing of conceptions, and consequently that of the births. Although the reproductive cycle of the females seems to be geared for estrus during the summer (possibly by photo period or weather cues), stimulation from courting by the males apparently plays an important role in bringing about the estrous period (as it is for domestic sheep, Shelton 1960). During the violent storms of the monsoons, almost any activity, including courtship, is inhibited. Thus it appears that females receive the courting stimulation required only during the breaks in bad weather. Estrus, and the subsequent conception are therefore confined to definite periods within the monsoon.

The Rut

Males joined the mixed groups just before the rut and courting began. Male competition was focused on the "right" to court a particular female. When a female came into estrus, the dominant male stayed with her, courting her occasionally. By his presence and threats he prevented subordinate males from courting or copulating with her, a practice referred to as tending. Since it was not possible for a single male to keep control of the courtship directed to two independently moving females, when a second female came into estrus she was tended by the second highest male in the hierarchy. Males which were tending made no attempt to influence the movement or activity of "their" female.

Occasionally a male which was tending was challenged, either by a previously subordinate male, or by a newly arrived male.

Rather than deferring to the dominance or threat displays of the dominant male, they reciprocated, and such interactions rapidly escalated into violent fights. These fights usually started with side clashing, the animals standing at an acute angle, clashing the outside of each horn against the opponent's, but generally changed to reverse parallel fighting. In reverse parallel fighting the tahr stood roughly shoulder to shoulder facing opposite directions. Each male attempted to deliver blows with the horns towards the belly or flank of the opponent, while at the same time, pivoting with his hindlegs to avoid his opponent's blows. These fights continued until one male gained a decisive advantage, or until one of the contestants gave up and took flight. The winner then proceeded to chase the loser, usually out of the group.

Population Dynamics

All accounts attest to the satisfactory reproductive performance of Nilgiri tahr populations. That is, however, not to say that there is not considerable variation. The estimated number of young per 100 adult females in various populations ranges between a low of 32 (Eravikulam in June 1978, Rice 1979) to a high of 89 (Eravikulam in October 1969, Schaller 1971), with a mean (of values obtained at various times of the year), of about 60 young per hundred females. The reproductive rate probably varies with minor fluctuations in populations levels and the availability of food resources to the tahr.

However, despite a healthy production of young, the sizes of populations for which we have information have remained almost

constant. Since there are no indications of significant emigration, on the average the mortality rates of these populations must equal the birth rates. This means that in Eravikulam National Park, for instance, about 125 tahr die each year. Although it is not possible to state the exact extent the various factors are responsible for these deaths, the major causes of mortality can be identified. During the study these were predation by leopard, by Asiatic wild dog, and by man in the form of poaching. There was no indication that tahr died directly from disease, but parasitic infection may play a role in determining which animals fall prey to predators. For example, one female showed remarkable lethargy in her response to being attacked by Asiatic wild dogs, and examination of her intestines revealed a heavy tapeworm infestation.

Food Habits

Tahr are primarily grazers, most of their diet being grasses, and to a lesser extent grassland forbs, and the forbs and shrubs which grow on the steep slopes near cliffs and slabs. They also grazed along the fringes of the sholas, and (apparently) when grazing was at its worst, they penetrated a maximum of about 10 m into the sholas.

OTHER SPECIES

In addition to Nilgiri tahr, a number of other species of conservation interest occur within Eravikulam National Park.

Plants

Although the vegetation of Eravikulam National Park closely resembles that of the Nilgiri Plateau, the region is unique in some ways, particularly in the diversity of the species in the family Balaceae (Shetty and Vivekananthan 1971). This family is well represented in the park. Shetty and Vivekananthan list 7 plant species endemic to Eravikulam National Park and an additional 16 species which are endemic to the High Range.

Gaur (Bos gaurus)

Although they are primarily forest animals, gaur come onto the open plateau to graze, and inhabit the forests of the peripheral areas of the park. Wildlife Preservation Officer Mohan Alambuth and I agreed on a population estimate of approximately 70 gaur in the area.

Tiger (Panthera tigris)

Tiger are present, but not in great numbers. In fact, all sightings during the course of my study in which I was close enough to note the facial markings were of the same adult female. Occasionally pug marks of an adult male were seen, and M. Alambuth (pers. comm.) saw a subadult and pugmarks of its mother and siblings, indicating that reproductive potential has not been lost. Their primary prey were sambar (Cervus unicolor) and gaur to a lesser extent.

Leopard (Panthera pardus)

Leopard are present in Eravikulam National Park in both spotted and black phases. Their numbers were difficult to

estimate, but there were probably several present. They preyed on sambar, tahr, and barking deer (Muntiacus muntjak) in that order of frequency. On the other hand, judging from the examination of leopard droppings, Nilgiri tahr are the main prey of leopard in the Mukerti area of the Nilgiri Plateau.

Asiatic Wild Dog (Cuon alpinus)

Asiatic wild dog were seen only occasionally either alone or in pairs during most of the study. However, a pack of 9 (including 2 pups) were active in the area during the last 9 months (January to September 1981). During that time they made numerous kills, mostly of sambar fawns, and of a few young and adult tahr. In 1981, the High Range Wildlife Preservation Association wildlife guide R. Mudhuvan told me that for the previous 5 years, these wild dogs had followed cyclical vertical migration in the Western Ghats. They were said to operate in packs of 20 to 25 animals in the jungles to the northeast (around Chinnar), and move up onto the highlands and break up into smaller groups about every 6 months. They then remained in the high country for 6 to 8 weeks before returning to lower elevations. He also maintained that their numbers were increasing.

Asiatic Elephant (Elephas maximus)

Although there were no elephants resident within the national park, small groups did pass though occasionally. They spent little time on the plateau and they usually crossed it in the course of a night. On the other hand, droppings and trails indicate that their use is more extensive in some of the forested

areas in the park (e.g. the northern extension of Turner's Valley), and those on the fringes of the park (e.g. the upper portions of Inaccessible Valley), or the area around Erumal Patti.

Nilgiri Marten (Martes gwatkinsi)

Little is known about the Nilgiri marten and even its distribution and status remain unclear. Although they are a forest animal, Nilgiri marten were seen crossing grassland on three occasions during the study: one pair, and 2 solitary animals. R. Mudhuvan (pers. comm.) reports that they may be readily located in the nearby lowland jungle to the northeast (between Marayoor and Chinnar).

CONSERVATION AND MANAGEMENT AT ERAVIKULAM NATIONAL PARK

Burning

Current policy is that some grassland should be burned every spring using a rotational system, so that any given area is burned every 2 or 3 years. Areas near Vaguvarrai and Eravikulam are burned intentionally as part of a management scheme, while more remote areas are often set ablaze by trespassers. Given adequate moisture, the perennial grasses quickly sprout succulent green shoots, which are favored by the tahr. So favored in fact, that about 60 tahr deserted their common home range in 1981 to graze on these shoots. In addition, observations on play in young suggest that burning is beneficial to the tahr. In January 1980, recently born young were commonly observed running, playing

and fighting, but such activities were seldom seen during February and March. However, with the improved foraging conditions following burning, these activities resumed and increased in frequency. For these reasons, it is suggested that the practice of burning be maintained.

However, certain aspects of the burning program could be improved. In 1980 for instance, burning in the Vaguvarrai and Eravikulam areas was carried out over a period of 3 days, with the result that the entire home range of some animals was burned. Although this did not seem to cause any hardship, a staggered burning program would probably be more beneficial. Burning during the fair weather in October might also be possible, and this would make fresh vegetative regrowth available to females late in gestation and early lactation. A more detailed burning plan could easily be devised, but its execution would require a greater amount of manpower and supervision than has been allotted to the task.

National Park Boundaries

As is shown in Figure 4, there is a considerable area used by Nilgiri tahr which is situated outside the National Park. Much of this area is used primarily by a few adult males. These peripheral portions of the male ranges are often at lower altitudes, and are therefore much more accessible to poachers. The finger of tahr range projecting into Inaccessible Valley (which is, in actuality, quite accessible) is a case in point. I once watched 3 armed men with the aid of dogs pursue an adult male in that area. In other instances, substantial parts of

common home ranges for females and subadults lie outside the National Park, particularly on the north side of Anai Mudi, at the head of Inaccessible Valley and on the gently west sloping side of Erumal Patti. It should be pointed out that tahr are completely protected, both inside and outside the National Park. However, forest officers in charge of areas bordering the Park have numerous other responsibilities, and strict protection of wildlife in the most distant portions of their areas of jurisdiction cannot be reasonably expected. Therefore, it is recommended that areas which tahr utilize that do not receive adequate protection at present be included within the park. Since wildlife protection is a high priority within the park, this would place the entire Eravikulam tahr population under this protection.

In addition, forested areas immediately adjacent to Eravikulam National Park are essential to many of the other large mammal species found there. Since the National Park boundary often follows the edge of the plateau, most of the terrain included is grassland. Although tiger, gaur, elephant, leopard, and other forest species do visit the grassland, they primarily inhabit the forests. Therefore, the effectiveness of the Park in preserving a wide variety of species would be greatly enhanced by including additional forested areas within the park.

Consequently, in addition to the minor boundary adjustments needed to include all the terrain used by the tahr, the 2 larger additions listed below would be very advantageous in conserving these other species. Considering the convenience and improved effectiveness of making park boundaries coincident with

geographical features or political boundaries, these additions are recommended along the following lines:

1). The upper reaches of Inaccessible Valley. It is my understanding that an addition to the park has been suggested previously in this area. It had as its boundary, two tributaries of the Nadalkal Ar (the river, which drains Inaccessible Valley); one originating on the plateau just east of Samba Malai, and the other dropping from the northeast slopes of Raja Malai. It is recommended that the northern half of this addition be extended further to the west. This would be an excellent addition, as it would include the area Nilgiri tahr use on the north side of Anai Mudi, and all the area tahr use at the head of Inaccessible Valley, besides offering additional protection to forest species.

2). Besides being a frequently used part of a tahr common home range, the grassy west facing slopes of Erumal Patti are probably the best place in the area to see gaur, as they frequently move out of the adjacent forest and onto the meadows to graze. There is ample evidence that elephant move through the area as well. However, this area falls outside the park and it is therefore recommended that the northern boundary of the park be made to coincide with the state line between Kerala and Tamil Nadu in this area, to encompass all the area used by tahr and some of the forest below.

Boundary Demarcation

At present, the boundary of the National Park, as described by the Kerala Government notification, is clearly marked only where it coincides with the state boundary, or the old Kanan

Devan Hills Produce Corporation boundary. In other areas, the distinction between National Park, Reserve Forest and tea company land is not clear. Such is the case, for instance, with the ridge that extends west from the Rajamallay salt lick, between Rajamallay and Kadalaar Estates, or the region between Perumal Malai and Chattamunnar Estate along the eastern boundary. Both the enforcement officers and leading conservationists in the area were not completely clear on the extent of the park in these areas and, to my knowledge, no adequate map of the National Park exists. Therefore, it seems advisable that a survey of the boundary be completed, and an authoritative map produced (including extensions and additions).

Reducing Disturbances

People enter the Eravikulam National Park illegally to obtain both animal and plant products. Sambar and gaur are often pursued with firearms, and Nilgiri tahr are also often hunted with the aid of domestic dogs. Wire snares are also used, particularly in areas near settlements where they can be easily checked. It can be extremely difficult to reduce this type of disturbance since it requires constant vigilance on the part of the enforcement staff, and a willingness to patrol portions of the park not accessible without considerable effort. Also, since the violators are armed, pursuit and capture by enforcement personnel is impossible if they are not armed as well. In addition, effective reduction in this type of activity can only be accomplished if those apprehended are punished accordingly which requires the cooperation of the local judiciary.

There are two plants which are harvested from Eravikulam National Park. Cane grows in the lower forested valleys, is used for handicrafts such as furniture. The second is a small insectivorous plant, Drosera peltata. This is gathered from the grassland in October, a time when it is widely distributed throughout the park (and presumably other grassland areas). This plant is desired for its medicinal properties. Curtailment of these activities has been hampered in the past by the practice of local forest offices of issuing permits for their collection within the park, despite their lack of authority to do so. Thus, the cooperation of Forest Department Officials and their superiors is needed in order to halt these activities.

Management and Development

Given the near pristine conditions prevailing within Eravikulam National Park and its small size, and the fact that the major object of the park is the protection and preservation of the natural system, an extremely conservative attitude towards management and development is suggested. Special consideration should be given to maintaining the ecological and scenic integrity of the area. The healthy and stable population of Nilgiri tahr is an indication of the health and stability of the park as a whole. Consequently, there is no evidence that any remedial management is needed. Rather, the major focus should be upon removing, or at least minimizing, disturbances.

Although the presence of Nilgiri tahr may have been the primary reason for creating the National Park, this does not mean that maximizing the tahr population should be the primary

management objective, especially considering the large population. Rather, the objective should be to maintain the tahr and the entire ecosystem in which they have evolved. In this context provisioning and pasture development are inappropriate. Also, despite indications of a fairly high incidence of parasites in tahr, there is no indication that this is threatening the population. It is more likely that the parasites, in conjunction with varying levels of forage, the density of the tahr, and the predators in the park, act as an important natural mechanism maintaining the tahr population at ecologically sound levels. Therefore, it is recommended that no therapeutic or prophylactic measures be undertaken in this regard.

Public use should also be considered in light of the uniqueness and majesty of the area. Every year more and more grassland in the western ghats is lost to plantations of wattle and eucalyptus (Davidar 1976, 1978), and before long Eravikulam National Park may remain as a last vestige of the original plateau grassland habitat. It therefore seems appropriate that this remnant should be kept in its original condition as much as possible. This will benefit, not only the plant and animal species now found within the National Park, but visitors to the park as well. Just as every year more and more Indians are discovering the value of their natural wildlife heritage, so are they discovering the value of the little undisturbed wilderness that India has left. Those who wish to see the park and Nilgiri tahr without leaving their cars may do so at the Rajamallay checkpoint. With roads penetrating every other corner of the high

country, it would seem fitting to leave Eravikulam National Park as a last remnant of wilderness in South India place where people can come to appreciate their natural heritage without the help of internal combustion engines.

Future Investigations

Continued monitoring and study of the ecology of Eravikulam National Park is needed, both to better understand the functioning of the ecosystem, and to assess the status of conservation issues. Consequently the following investigations are suggested:

- 1). Annual census and estimate of reproduction of Nilgiri tahr. Eight to 12 days are required to completely census all areas of the park. If personnel or time are limiting, all common home range areas need not be counted every year. If the personnel have adequate experience, then all animals should be classified by sex and age, which would give an estimate of reproduction for the year, provided the counts are done after most of the births, i.e. in March.

- 2). Faunal and floral species inventory. The only systematic plant collections done to date have been those by Shetty and Vivekananthan (1971) in the area of Anai Mudi, and my own collections from grassland areas. A more comprehensive floral collection and survey should be undertaken or encouraged to identify key floral elements and endangered and rare species. At present only incidental observations are available for vertebrates other than large mammals. The park's assets in these areas should be inventoried.

3). Continued research on the ecology of Nilgiri tahr and other species. The Nilgiri tahr population at Eravikulam National Park should be studied further. Such information will be highly useful for future conservation efforts, both within the park, and elsewhere. In addition, the parks capability to support sustainable populations of other mammals, particularly the large predators, needs to be investigated.

4). The effects of fire on grassland. Burning should be continued because it is a practice of long standing, and is beneficial to the tahr. However, the long term effects of burning on the grassland in terms of species composition, vegetative cover, productivity, nutrition and soils need to be assessed.

CAPTIVE PROPAGATION

With only about 2,200 Nilgiri tahr in the wild, the success of captive breeding is reassuring. However, such efforts may flounder due to the results of inbreeding depression if the entire captive stock continues to be developed entirely from the original small group (Frankel and Soule 1981). Proposals to augment the genetic material in the captive populations has met with approval from the Indian authorities on the state and national levels. However, current regulations governing the importation of both wild animals and semen into the United States have blocked all efforts in this direction. Continued efforts to find ways of increasing the genetic diversity in captive groups

without endangering the health of domestic and native American stock are essential if captive breeding programs of this and other species are to be successful in the long run.

Captive groups can also play an important role in educating visitors about endangered species. An informative display at the Trivandrum Zoo would help increase the public's awareness of the status of this unique animal occurring in their state.

REGIONAL STRATEGIES FOR CONSERVATION

Sport Hunting

In view of the historical significance played by sport hunters and their organizations in conserving the two largest populations of Nilgiri tahr, the possibility of reopening tahr to sport hunting should not be dismissed. Although it may seem strange to hunt an animal of which only a couple of thousand survive, such a policy might be the most effective method of perpetuating some populations. This is simply because it is in the vested interest of these organizations to maintain a healthy standing crop of animals from which to select a small number of trophies. Since sport hunting is for trophies, the mortality from hunting would be confined to adult males. Thus, as Davidar (1976) has pointed out, hunters who maintain a population of tahr for hunting purposes, give absolute protection to over 90% of the population (the females and subadults).

Without any prospect of pursuing their traditional interest in sport hunting, many members of the High Range Wildlife

Preservation Association and the Nilgiri Wildlife Association have lost much of their previous interest in wildlife and conservation in their respective regions. As a consequence the cause of conservation in those areas has lost a valuable ally. By removing Nilgiri from Schedule I of the Wildlife Act, and reopening hunting at one or two selected sites, the involvement, participation and support of these and other similar organizations could be reestablished. For such a system to work as well as it has in the past, these organizations should be afforded a large role, if not the primary role, in the protection, management, administration and costs of maintaining the hunting activities in such areas.

Any plan for hunting would require close management and supervision. This would be required to guard against over-harvest and excessive stress being incurred as a result of the social disruption associated with harvesting trophy males only (Stringham and Bubenik 1975).

Reintroductions

Davidar (1978) has made an assessment of the status and condition of all areas where he located Nilgiri tahr, or where they have existed in the recent past. While reintroductions can in no way compensate for effective enforcement and protection, and will never be successful without these measures, Nilgiri tahr are likely candidates for reintroductions into parts of their range once the agents responsible for their extirpation have been eliminated. Although they do show affinities for particular ranges, their fidelity to these areas is not absolute, and

Nilgiri tahr are probably able colonizers of new range, as their close relatives the Himalayan tahr have proved to be in New Zealand (Caughley 1970).

Such reintroductions might require some experimentation, but would probably best be done with groups of animals. Because males leave their original birth ranges, and travel more widely than do females, the initial group might best be a group of males. They would presumably be more accustomed to new terrain, and also less essential to the maintenance of the parent population. The male group could then be followed by a group of females if it manages to survive the initial few months of adjustment. On the other hand, if the males desert the reintroduction site immediately, a group of the more sedentary females might prove more successful. For mountain sheep (Ovis canadensis), Geist (1975) proposed that lambs imprinted to humans be led over the new range, and after a year wild yearlings be released with them. Such an involved scheme would probably not be necessary with tahr, but the possibility of using it should be kept in mind, should the initial efforts fail.

Reintroduction might be coupled to a proposal for sport hunting to great advantage. A club or organization could take on the responsibilities for the protection of the new area and assist in the logistics of the transfer. In return they would have the right to hunt the tahr once the population reached a level at which it could support a sustained yield.

Other Large Mammals

Because of the small size of many parks and sanctuaries in this region, large mammals, particularly elephants and the large carnivores, cannot be effectively conserved within their boundaries. For these species, populations of adequate size can only be maintained through cooperative management policies in adjoining areas of forest, with greater emphasis placed upon conservation and the maintenance of ecological stability in these areas. This implies a reassessment of current policies which are directly focused on the generation of revenue, a change needed in the formulation of policy on forestry operations as well (Gadgil et. al.).

CONCLUSIONS

Thanks to the efforts of the individuals, organizations and governments involved, the survival of Nilgiri tahr seems assured in the near future. While there is ample cause for a feeling of satisfaction at having arrived at that state, the potential exists for improvement and development in the maintenance and study of these populations. Current recommendations include the need to continue to monitor the status of existing populations, and integrate management of wildlife areas in the region in a more coordinated manner. As conditions improve, the opportunity to renew sport hunting activities may be considered as an effective conservation strategy for Nilgiri tahr.

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LITERATURE CITED

- Baig, A. and W. Henderson. (1978): A Centenary of Planting in the Kanan Devan Hills Concession, 1879-1978. Tata Finlay Ltd.
- Caughley, G. (1970): Liberation, Dispersal and Distribution of Himalayan Tahr (Hemitragus jemlahicus) in New Zealand. New Zealand J. Sci. 13: 22-39.
- Caughley, G. (1971): The Season of Births for Northern-hemisphere Ungulates in New Zealand. Mammalia 25: 204-219.
- Davidar, E.R.C. (1976): Census of the Nilgiri Tahr in the Nilgiris, Tamil Nadu. J. Bombay Nat. Hist. Soc. 73: 142-148.
- Davidar, E.R.C. (1978): Distribution and Status of the Nilgiri Tahr (Hemitragus hylocrius) --1975-78. J. Bombay Nat. Hist. Soc. 75(3): 815-844.
- Frankel, O.H. and M.E. Soule. (1981): Conservation and Evolution. Cambridge.
- Gadgil, M., S.N. Prasad and R. Ali. (1983): An Alternative Forest Policy. WWF-India Newsletter No. 44. 4(1): 2-4 & 10.
- Geist, V. (1971): Mountain Sheep. Chicago.
- Geist, V. (1975): On the Management of Mountain Sheep: Theoretical Considerations. pp. 77-100. In: J.B. Trefethen (ed). The Wild Sheep in Modern North America. New York.
- Goodwin, H.A. and C.W. Holloway. (1972): Red Data Book. Vol. 1, Mammalia. Morges.
- Green, M.J.B. (1978): The Ecology and Feeding Behaviour of the Himalayan Tahr (Hemitragus jemlahicus) in the Langtang Valley, Nepal. Unpublished M.Sc. Thesis. Univ. of Durham, England.
- Munton, P. [1979]: The Conservation of the Arabian Tahr Hemitragus jayakari. Project 1290 IUCN/WWF Joint Operations (unpublished manuscript).
- Nievergelt, B. (1974): A Comparison of Rutting Behaviour and Grouping in the Ethiopian and Alpine Ibex. pp. 324-340. In: Geist, V. and F. Walther (eds). The Behavior of Ungulates and Its Relation to Management. IUCN New Series No. 24. Morges.

Rice, C.G. (1979): Further Observations on Nilgiri tahr (Hemitragus hylocrius) in Eravikulam National Park, Kerala, India. Unpublished Report to the New York Zoological Society.

Schaller, G.B. (1971): Observations on Nilgiri tahr (Hemitragus hylocrius Ogilby 1838). J. Bombay Nat. Hist. Soc. 67:365-389.

Schaller, G.B. (1973): Observations on Himalayan tahr. J. Bombay Nat. Hist. Soc. 70(1): 1-24.

Schaller, G.B. (1978): Mountain Monarchs. Chicago.

Shelton, M. (1960): Influence of the Presence of Male Goat on the Initiation of Estrous Cycling and Ovulation of Angora Does. J. Anim. Sci. 19: 368-375.

Shetty, B.V. and K. Vivekananthan. (1971): Studies on the Vascular Flora of Anaimudi and the Surrounding Regions, Kottayam, Kerala. Bull. Bot. Surv. India. 13(1&2): 16-42.

Stringham, S.S. and A.B. Bubenik. (1975): Condition Physique et Taux de Survie du Chamois, Rupicapra rupicapra L. en Fonction des Classes d'age et de Sexe de la Population. Bulletin de l'office National de la Chasse. Etudes Scientifiques et Techniques. Special No. 3: 199-224.

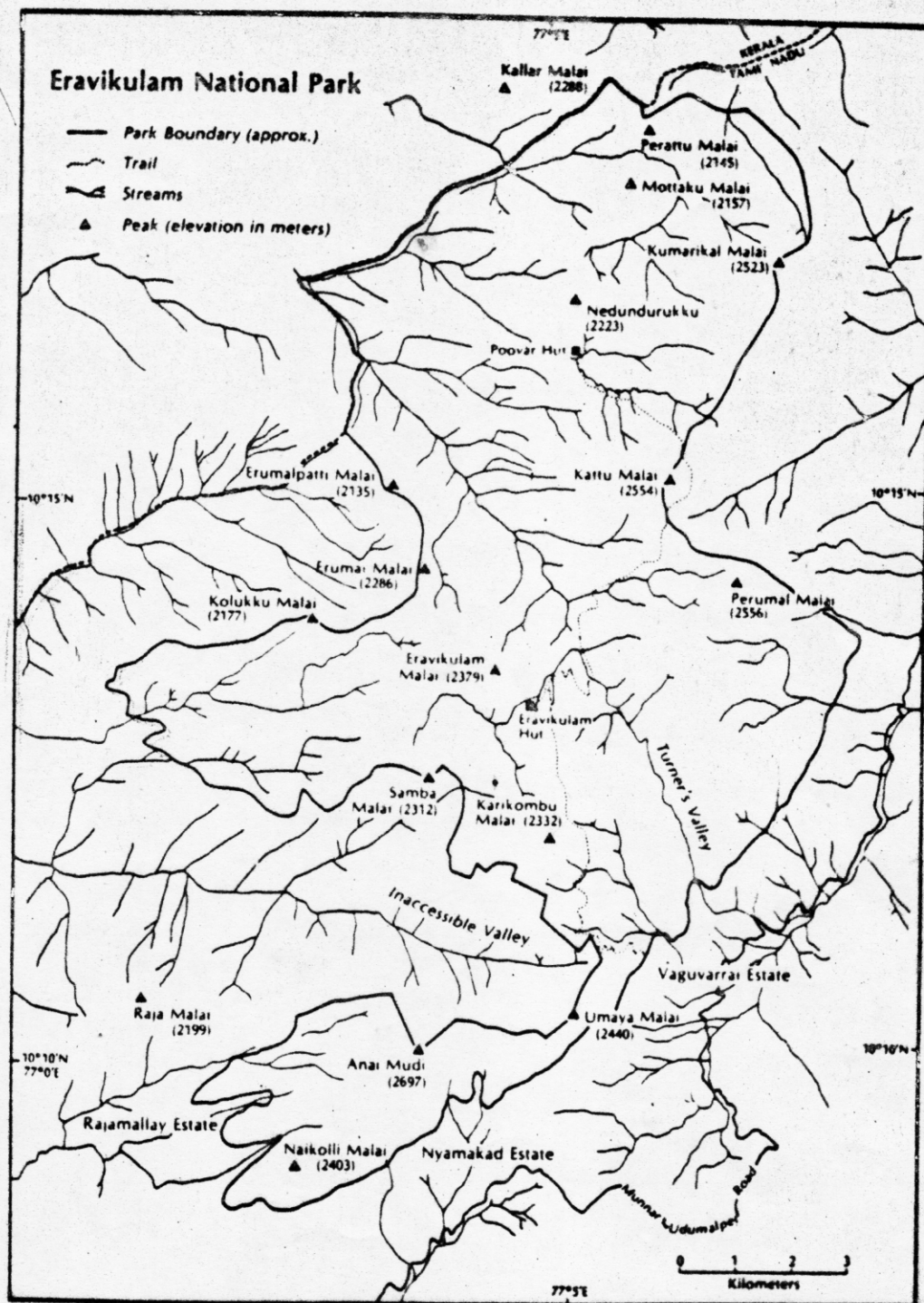


Figure 1. Approximate boundary of Eravikulam National Park, Kerala.

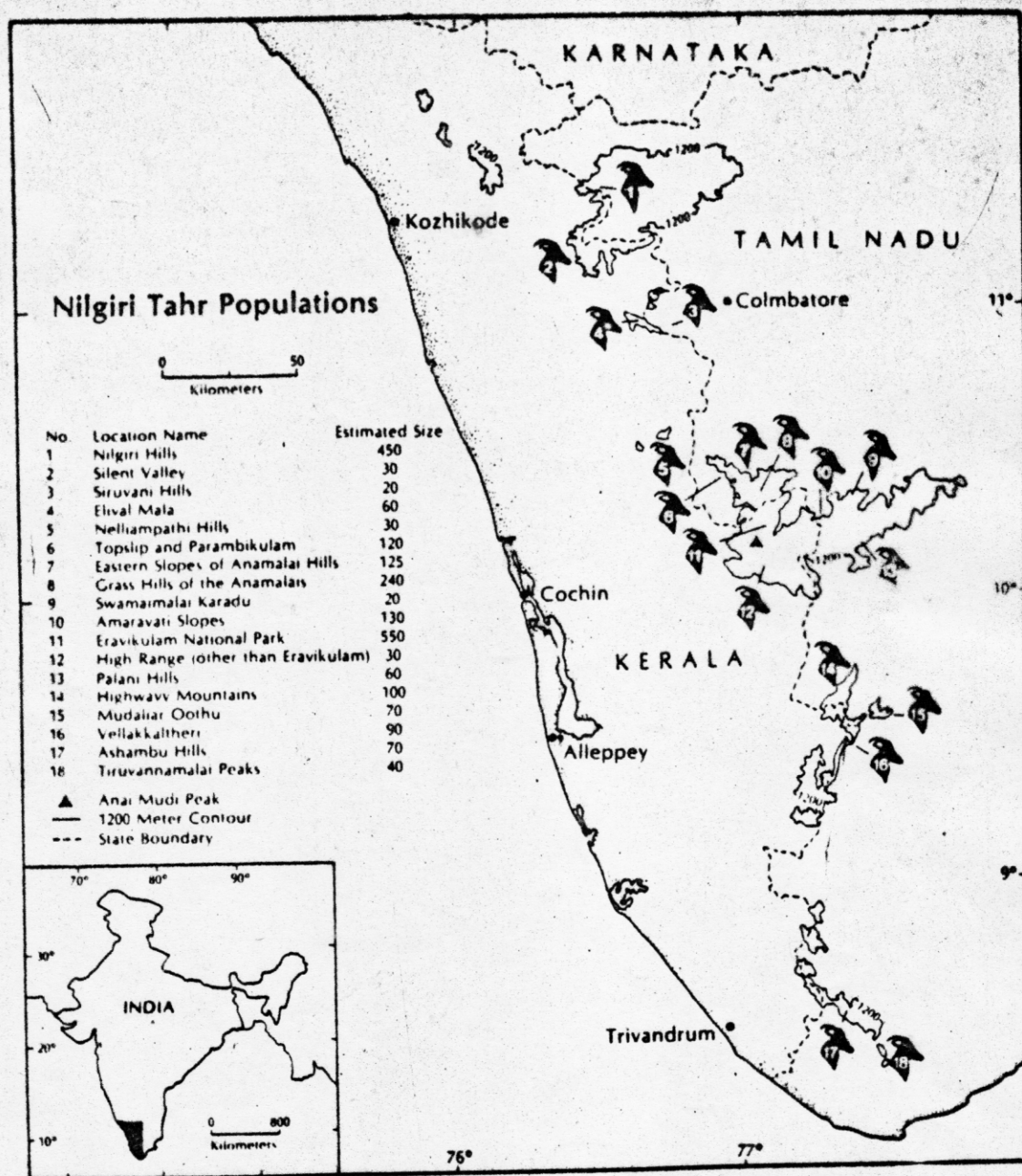


Figure 2. Distribution and estimated size of Nilgiri tahr populations in South India (based on Davidar 1978 and this study).



Figure 3. A mixed group of Nilgiri tahr in typical habitat.
Note the steep rock slabs and shola (forest) covered valley
in the background.

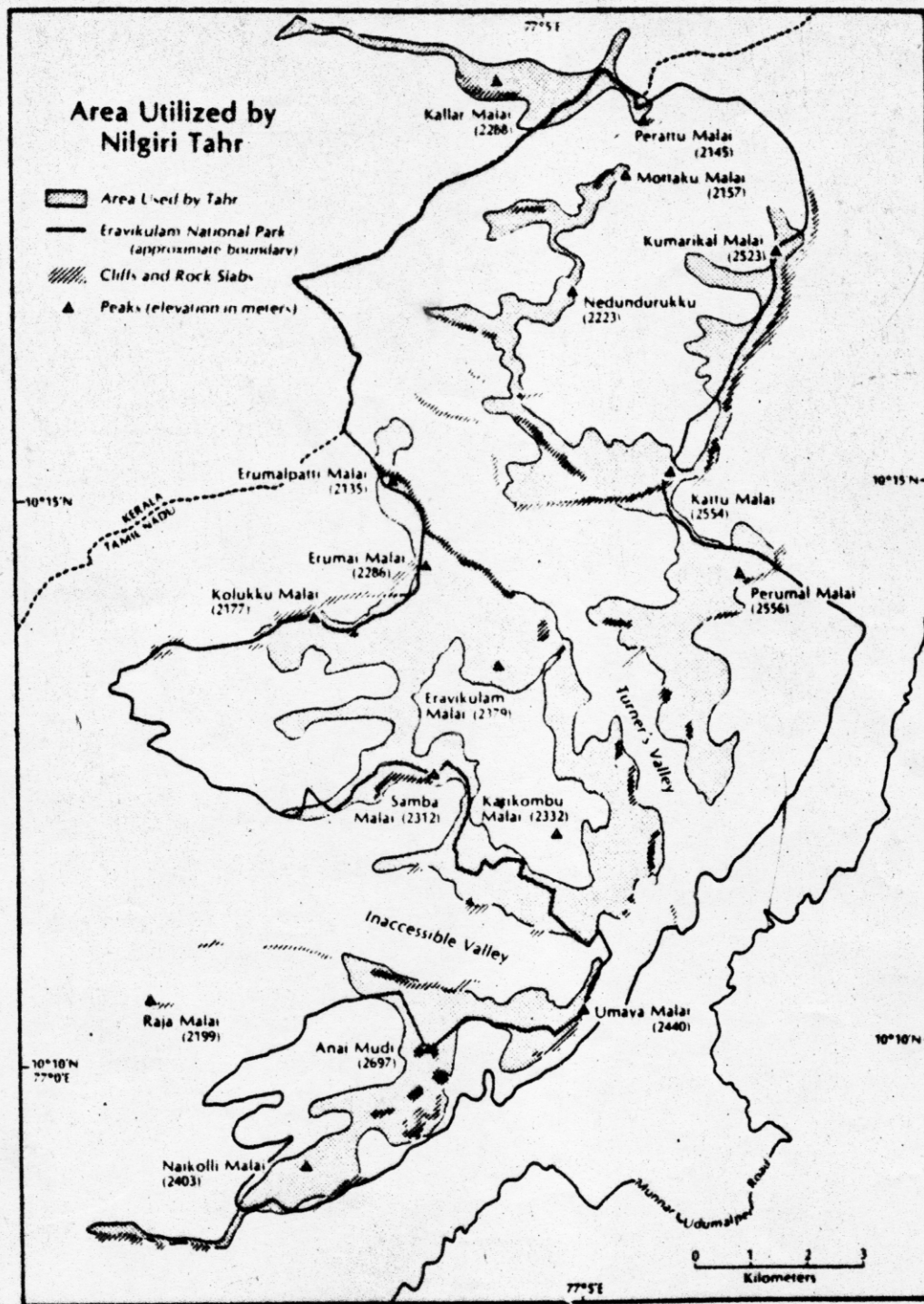


Figure 4. Area used by Nilgiri tahr in Eravikulam National Park and environs.